What is claimed is:

1. A method for making a thin metal oxide film, comprising the steps of:

preparing a first solution having at least one metal salt dissolved therein;

preparing a second solution having a water soluble polymer dissolved therein;

combining the first solution and the second solution at a predetermined ratio to form a third solution;

depositing a layer of the third solution on a substrate; and

heating the substrate having the third solution layer thereon at a temperature sufficient to oxidize the at least one metal salt to form the thin metal oxide film.

2. The method as defined in claim 1 wherein the first solution comprises at least two metal salts, the at least two metal salts having been dissolved individually into water and combined at a predetermined ratio to form the first solution.

3. The method as defined in claim 1 wherein the second solution comprises the water soluble polymer dissolved in a solvent.

4. The method as defined in claim 3 wherein the solvent is at least one of water and isopropyl alcohol.

5. The method as defined in claim 4 wherein the water soluble polymer is polyvinylalcohol.

6. The method as defined in claim 5 wherein the at least one metal salt is at least one of cerium nitrate, samarium nitrate, gadolinium nitrate, praseodymium nitrate, cerium chloride, samarium chloride, gadolinium chloride,

praseodymium chloride, indium tin oxide, yttria-stabilized zirconia (YSZ), samarium strontium cobalt oxide (SSCO), gadolinium doped ceria, and mixtures thereof.

7. The method as defined in claim 1 wherein the at least one metal salt is at least one of acetates, nitrates, halides, and sulfates of at least one of cerium, samarium, indium, gadolinium, praseodymium, yttrium, zirconium, strontium, and cobalt, and mixtures thereof.

8. The method as defined in claim 1 wherein the water soluble polymer is at least one of polyvinyl alcohols, starches, hydrocolloids, cellulose ethers, polyethylene oxides, polyacrylates, polyacrylamides, polyamines, polyimines, and mixtures thereof.

9. The method as defined in claim 8 wherein the water soluble polymer is polyvinyl alcohol.

10. The method as defined in claim 1 wherein the substrate is one of single crystal silicon, polycrystalline silicon, silicon oxide containing dielectric substrates, alumina, sapphire, ceramic, cermets, and mixtures thereof.

11. The method as defined in claim 1, further comprising the step of varying the predetermined ratio to achieve a viscosity of the third solution which is sufficient for deposition by at least one of spin coating, spray coating, and dip coating.

12. The method as defined in claim 1 wherein the depositing step is accomplished by at least one of spin coating, spray coating, and dip coating.

13. The method as defined in claim 1 wherein the heating step is accomplished at a temperature sufficient to oxidize the water soluble polymer and the at least one metal salt.

14. The method as defined in claim 1 wherein the heating step is accomplished at a temperature ranging between about 400°C and about 1200°C.

15. The method as defined in claim 14 wherein the heating step is accomplished at a temperature ranging between about 540°C and about 1050°C.

16. The method as defined in claim 1 wherein the metal oxide film has a thickness ranging between about 0.05 μm and about 5.0 μm.

17. The method as defined in claim 16 wherein the metal oxide film has a thickness ranging between about 0.1 μm and about 1.5 μm.

18. The method as defined in claim 1 further comprising the step of modifying a grain structure of the metal oxide film.

19. The method as defined in claim 18 wherein the modifying step is accomplished by heating the metal oxide film.

20. The method as defined in claim 19 wherein the modifying heating step is accomplished at temperatures ranging from about 400°C to about 1500°C.

21. The method as defined in claim 1, further comprising the steps of:

depositing a subsequent layer of the third solution on the metal oxide film; and

heating the metal oxide film having the subsequent layer thereon to achieve a predetermined thickness of the metal oxide film.

22. The method as defined in claim 21 wherein the thickness of the thin metal oxide film ranges between about 5.0 μm and about 20.0 μm.

23. A thin metal oxide film produced by the process of claim 1.

24. A fuel cell, comprising:

at least one electrode operatively disposed in the fuel cell; and

an electrolyte in electrochemical contact with the at least one electrode;

wherein at least one of the electrode and the electrolyte are formed by a process comprising the steps of:

preparing a first solution having at least one metal salt dissolved therein;

preparing a second solution having a water soluble polymer dissolved therein;

combining the first solution and the second solution at a predetermined ratio to form a third solution;

depositing a layer of the third solution on a substrate; and

heating the substrate having the third solution layer thereon at a temperature sufficient to oxidize the at least one metal salt to form the metal oxide film.

25. The fuel cell as defined in claim 24 wherein the electrode comprises an anode and a cathode.

26. The fuel cell as defined in claim 24 wherein the first solution comprises at least two metal salts, the at least two metal salts having been dissolved individually into water, and combined at a predetermined ratio to form the first solution.

27. The fuel cell as defined in claim 24 wherein the second solution comprises the water soluble polymer dissolved in a solvent.

28. The fuel cell as defined in claim 27 wherein the solvent is at least one of water and isopropyl alcohol.

29. The fuel cell as defined in claim 28 wherein the water soluble polymer is polyvinylalcohol.

30. The fuel cell as defined in claim 29 wherein the at least one metal salt is at least one of cerium nitrate, samarium nitrate, gadolinium nitrate, praseodymium nitrate, cerium chloride, samarium chloride, gadolinium chloride, praseodymium chloride, indium tin oxide, yttria-stabilized zirconia (YSZ), samarium strontium cobalt oxide (SSCO), gadolinium doped ceria, and mixtures thereof.

31. The fuel cell as defined in claim 24 wherein the at least one metal salt is at least one of acetates, nitrates, halides, and sulfates of at least one of cerium, samarium, indium, gadolinium, praseodymium, yttrium, zirconium, strontium, and cobalt, and mixtures thereof.

32. The fuel cell as defined in claim 24 wherein the water soluble polymer is at least one of polyvinyl alcohols, starches, hydrocolloids, cellulose ethers, polyethylene oxides, polyacrylates, polyacrylamides, polyamines, polyimines, and mixtures thereof.

33. The fuel cell as defined in claim 32 wherein the water soluble polymer is polyvinyl alcohol.

34. The fuel cell as defined in claim 24 wherein the substrate is one of single crystal silicon, polycrystalline silicon, silicon oxide containing dielectric substrates, alumina, sapphire, ceramic, cermets, and mixtures thereof.

35. The fuel cell as defined in claim 24 wherein the predetermined ratio is varied to achieve a viscosity of the third solution which is sufficient for deposition by at least one of spin coating, spray coating, and dip coating.

36. The fuel cell as defined in claim 24 wherein the depositing step is accomplished by at least one of spin coating, spray coating, and dip coating.

37. The fuel cell as defined in claim 24 wherein the heating step is accomplished at a temperature ranging between about 400°C and about 1200°C.

38. The fuel cell as defined in claim 24 wherein the metal oxide film has a thickness ranging between about 0.05 μm and about 5.0 μm.

39. An electronic device, comprising:
a load; and
the fuel cell of claim 24 connected to the load.

40. A method for using a fuel cell, comprising the step of:
operatively connecting the fuel cell to at least one of an electrical load and an electrical storage device, the fuel cell comprising at least one electrode, and an electrolyte in electrochemical contact with the at least one electrode, wherein at least one of the electrode and the electrolyte are formed by a process comprising the steps of:

preparing a first solution having at least one metal salt dissolved therein;

preparing a second solution having a water soluble polymer dissolved therein;

combining the first solution and the second solution at a predetermined ratio to form a third solution;

depositing a layer of the third solution on a substrate; and

heating the substrate having the third solution layer thereon at a temperature sufficient to oxidize the at least one metal salt to form the metal oxide film.

41. The method as defined in claim 40 wherein the at least one electrode is one of an anode and a cathode.

42. A thin metal oxide film, comprising:

a solution of at least one metal salt and at least one water soluble polymer; and

means for converting the metal salt and water soluble polymer solution into the thin metal oxide film.

43. A method for making a thin metal oxide film, comprising the steps of:

mixing about 5 g of $CeCl_3$ in about 10 mL of de-ionized water;

mixing about 1.4 g of $SmCl_3$ in about 10 mL of de-ionized water;

mixing the $CeCl_3$ solution and the $SmCl_3$ solution to render a first solution having $CeCl_3$ and $SmCl_3$ dissolved therein;

mixing about 10% by weight polyvinylalcohol, about 75% by weight water, and about 15% isopropyl alcohol to render a second solution of about 20 mL, the second solution having the polyvinylalcohol dissolved therein;

combining the first solution and the second solution to form a third solution;

depositing a layer of the third solution on a silicon substrate; and

heating the substrate having the third solution layer thereon at about 540°C to oxidize the cerium and samarium salts to form a samarium doped ceria metal oxide film.

44. A method for making a thin metal oxide film, comprising the steps of:

preparing a solution having at least one metal salt and at least one water soluble polymer dissolved therein, wherein the at least one metal salt and the at least one water soluble polymer are added at a predetermined ratio of metal salt to water soluble polymer;

depositing a layer of the solution on a substrate; and

heating the substrate having the solution layer thereon at a temperature sufficient to oxidize the at least one metal salt to form the thin metal oxide film.

45. The method as defined in claim 44 wherein the at least one metal salt is at least one of acetates, nitrates, halides, and sulfates of at least one of cerium, samarium, indium, gadolinium, praseodymium, yttrium, zirconium, strontium, and cobalt, and mixtures thereof.

46. The method as defined in claim 45 wherein the at least one water soluble polymer is polyvinylalcohol and wherein the solution further comprises water.

47. The method as defined in claim 44 wherein a temperature at which the at least one water soluble polymer oxidizes and the temperature at which the at least one metal salt oxidizes are substantially within the same range.

48. The method as defined in claim 47 wherein the heating step is accomplished at a temperature sufficient to oxidize both the at least one water soluble polymer and the at least one metal salt.